TREND OF LONGEVITY IN THE UNITED STATES.

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Every year the mortality statistics of about half of the states of this country covering many classes or groups of the population are collected and published by the federal government. This work has been carried on for about thirty years, although it has not always been on a yearly basis or involved so many states. Population statistics of a reliable character and for practically the same groups of all the states are collected each decade and this work has been carried on for about the same length of time, although much less satisfactory methods of taking the census date back as far as 1790.

In view of these statements it is very remarkable that so little is known about the relative health and longevity of the various groups of our population; for the information is available from mortality tables which could be constructed from the statistical data mentioned above.

The way in which the inhabitants of a community survive from year to year depends solely upon the values of the death rates at the various ages. If the values of these death rates are known—and they can certainly be determined from the statistical data collected by the federal government—they need only be applied successively to a hypothetical community of individuals all assumed to be of the same age—the earliest age under consideration—to show just how individuals will survive if those rates prevail in future years when the successive ages are attained. Now, such a column of death rates by ages and the results obtained by applying them to a hypothetical community constitute a mortality table. The American Experience Table constructed over seventy years ago from the

records of life insurance companies and used by practically all the life insurance companies of this country is such a table.

Relatively few mortality tables which describe mortality conditions in this country have been constructed because of the immense labor involved in computing and applying the death rates corresponding to so many ages and sometimes in graduating or smoothing the results.

In the Registrar-General's Report (British) for 1914 was explained what promises to be a highly useful method or scheme of constructing abridged mortality tables or mortality tables wherein the results are found for only certain ages, say, each fifth age.   Following such a scheme it is unnecessary to compute the results corresponding to the other ages and a vast amount of the computation otherwise necessary is eliminated. Furthermore, such abridged tables give practically all the information in regard to health at the various periods of life that the complete or unabridged tables would give.

The writer has adapted the scheme of computing abridged mortality tables to the case where the results are computed and given for only each *tenth* age and expects to publish shortly the necessary mathematical formulas in some mathematical journal.*   The time required for constructing such a table after the statistical data are collected and arranged is very little over an hour.

The special purpose of this article is to give the most essential results taken from eighteen abridged mortality tables computed according to the scheme mentioned above.   The mortality tables themselves are not given, because they would give practically no information not afforded by the tables of death rates and of expectations of life which are given below.

The statistical data used in the construction of the tables comprise the population and deaths for the three years, 1890, 1900 and 1910, of the seven states (Connecticut, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island and Vermont) which were the only states which were registration states *throughout* the two decades, 1890–1910, except for the year 1900 when the statistics for Vermont were necessarily omitted because of the faulty form in which the mortality statistics are published.

*See the October (1919) issue of the Bulletin of the American Mathematical Society.

Although the statistical data used in this article, like all other ordinary statistical data, undoubtedly contain some more or less serious inaccuracies, and being based upon single years must reflect peculiarities of those years to the extent as to forbid placing too much confidence in the absolute results given below, the results of so many closely related tables check so well and vary from age to age so smoothly relatively that certain facts—a few of which will be pointed out—seem fairly well established. Furthermore, estimates of the longevity of the various groups considered are presented here—as far as the writer can find—for the first time.

DEATH RATES (per 10,000).

FOREIGN-BORN WHITE.

	Males					Females				
Age	1890	Diff.	1900	Diff.	1910	1890	Diff.	1900	Diff.	1910
10......	50	−13	37	−9	28	50	−35	25	+71	96
20......	73	−16	57	−9	48	64	−27	37	0	37
30......	94	−14	80	−20	6C	62	+21	83	−23	60
40......	160	−39	121	−32	89	142	−23	119	−32	87
50......	232	−20	212	−20	192	198	−9	189	−36	153
60......	395	−18	377	+22	399	328	+31	359	−8	351
70......	661	+45	706	+87	793	616	+75	691	+85	776
80......	1368	+14	1382	+38	1420	1312	+214	1526	−184	1342

NATIVE WHITE—FOREIGN OR MIXED PARENTAGE.

10......	53	−23	30	+2	32	11	+30	41	−13	28
20......	73	−11	62	−15	47	67	−10	57	−16	41
30......	139	−22	117	−12	105	110	−18	92	−16	76
40......	130	−2	128	+23	151	117	−19	98	0	98
50......	155	+3	158	+49	207	135	+7	142	+4	146
60......	286	−20	266	+91	357	241	−7	234	+36	270
70......	441	+46	487	+153	640	459	0	459	+120	579
80......	1155	−351	804	+608	1412	1266	−214	1052	+144	1196

NATIVE WHITE—NATIVE PARENTAGE.

10......	45	−8	37	−6	31	41	−4	37	−6	31
20......	48	−3	45	+10	55	43	+4	47	−7	40
30......	63	+4	59	−12	47	57	−7	50	+3	53
40......	70	−3	67	−10	57	66	+4	70	−1	69
50......	92	+7	99	−7	92	96	+8	104	+4	108
60......	151	+25	176	+1	177	172	+26	198	+35	233
70......	297	+93	390	+18	408	338	+110	448	+36	484

The death rate varies so widely in the neighborhood of the year of birth and the necessary statistical data for that period are so lacking, that that period must be omitted in constructing abridged mortality tables.

EXPECTATION OF LIFE.
FOREIGN-BORN WHITE.

	Males					Females				
Age	1890	Diff.	1900	Diff.	1910	1890	Diff.	1900	Diff.	1910
10......	44.7	+1.7	46.4	+2.4	48.8	+47.2	+1.3	+48.5	−1.7	46.8
20......	37.2	+1.2	38.4	+2.1	40.5	39.8	+0.2	40.0	+1.9	41.9
30......	30.1	+0.7	30.8	+1.7	32.5	32.3	−0.3	32.0	+1.6	33.6
40......	23.4	+0.7	24.1	+0.5	24.6	25.0	−0.1	24.9	+0.8	25.7
50......	17.4	+0.2	17.6	−0.3	17.3	18.7	−0.6	18.1	+0.2	18.3
60......	12.0	−0.1	11.9	−0.6	11.3	12.9	−0.8	12.1	−0.2	11.9
70......	7.3	−0.2	7.1	−0.5	6.6	7.8	−0.5	7.2	−0.2	7.0
80......	3.3	−0.4	2.9	−0.4	2.5	3.6	−0.5	3.1	+0.1	3.2

NATIVE WHITE—FOREIGN OR MIXED PARENTAGE.

	Males					Females				
Age	1890	Diff.	1900	Diff.	1910	1890	Diff.	1900	Diff.	1910
10......	46.4	+2.1	48.5	−2.1	46.4	50.0	+0.5	50.5	+0.4	50.9
20......	39.3	+1.4	40.7	−2.4	38.3	41.7	+1.2	42.9	−0.4	42.5
30......	33.0	+0.9	33.9	−3.2	30.7	35.0	+0.7	35.7	−1.0	34.7
40......	27.4	+0.4	27.8	−3.3	24.5	28.8	+0.1	28.9	−1.5	27.4
50......	21.0	+0.4	21.4	−3.3	18.1	22.1	−0.1	22.0	−1.7	20.3
60......	14.8	+0.4	15.2	−2.8	12.4	15.6	−0.1	15.5	−1.8	13.7
70......	9.3	+0.6	9.9	−2.5	7.4	10.0	−0.4	9.6	−1.3	8.3
80......	4.8	+0.3	5.1	−1.8	3.3	6.9	−1.7	5.2	−1.3	3.9

NATIVE WHITE—NATIVE PARENTAGE.

	Males					Females				
Age	1890	Diff.	1900	Diff.	1910	1890	Diff.	1900	Diff.	1910
10......	56.1	−1.1	55.0	−0.9	54.1	57.6	−1.9	55.7	−0.1	55.6
20......	48.3	−1.2	47.1	−1.2	45.9	50.1	−2.3	47.8	−0.2	47.6
30......	40.5	−1.3	39.2	−1.4	37.8	42.6	−2.5	40.1	−0.1	40.0
40......	32.8	−1.5	31.3	−1.4	29.9	35.3	−2.8	32.5	−0.6	31.9
50......	25.1	−1.4	23.7	−1.5	22.2	27.9	−3.1	24.8	−0.9	23.9
60......	17.9	−1.3	16.6	−1.4	15.2	20.7	−3.1	17.6	−1.1	16.5
70......	11.5	−0.7	10.8	−1.4	9.4	14.5	−2.6	11.9	−1.7	10.2

Columns of death rates serve to point out the critical ages or ages at which a retrogression (or gain) begins or ends and so are fundamental when causes for a particular situation are sought. On the other hand, columns of expectations of life serve to show the way in which the effects of a particular situation are distributed throughout periods of life, some of which contribute nothing toward the particular situation.

Since, technically speaking, we are interested primarily in the total effects or results and not in the causes, the only comment we shall make upon the death rates is to point out the decided improvement from decade to decade at the earlier ages made by all three groups—both sexes—and the decided tendency to retrogress—especially natives of foreign or mixed parentage—at the higher ages. However, close examination

of the relative values of the death rates will disclose considerable information to those sufficiently interested.

The columns of expectations of life are especially illuminating. Thus, both of the groups, foreign-born and natives of foreign or mixed parentage, seem to have an average expectation of life of about forty-eight years at age ten (with the males as the favored sex in the former group and the females as the decidedly favored sex in the latter group), and since the average duration of life usually differs little from the expectation of life at age ten we have here a fairly good estimate of the average duration of life for these groups.

The foreign-born whites, however,—especially the males— seem to have gained in the average duration of life in spite of losses in expectation at the higher ages while the natives of foreign or mixed parentage show a total heavy loss at practically all ages for the two decades. The males of the latter group showed some improvement at all ages in the decade 1890–1900 but suffered a tremendous retrogression in the decade 1900–1910. The females of the same group also present a very bad record. The observing reader will probably wonder at this time what factors in the American mode of living have contributed most to this momentous retrogression.

Too much emphasis can not be given to the facts and tendencies shown by the expectations of life of native Americans whose parents were also native, the group which calls naturally for most of our attention. Two facts stand out clearly: (1) native Americans of native parentage enjoy remarkable longevity (the average duration of life of this group exceeds that of any of the other groups by five to ten years in any year); (2) they are gradually losing this heritage at a rate of about one year per decade. There may, possibly, be cases where a longer longevity is enjoyed by natives of other countries (such as say New Zealand or Sweden) but such examples are few—there may be none. The writer knows of no statistical evidence of such longevity being enjoyed anywhere else on earth.

The question naturally arises: Could native Americans of native parentage—once they become familiar through proper propaganda with the knowledge of their wonderful heritage

and the eminent possibilities of losing it—attain and maintain by conscious effort the longevity enjoyed twenty years ago?

The retrogression in longevity of native Americans of native parentage is not spasmodic as it is at some age-periods in the cases of the other two groups; the retrogression is definite and consistent and exists at every age in each decade and for both sexes. The retrogression among the males seems to be evenly distributed throughout the two decades, but the retrogression among the females seems to be confined mainly to the first decade giving some indication that the gentler sex has sized up the situation enough to cause them to face about. As a general rule females enjoy a greater longevity the civilized world over; it will be interesting to see what the statistical data of 1920 will disclose.

DEATH RATES—GENERAL POPULATION.

	Males					Females				
Age	1890	Diff.	1900	Diff.	1910	1890	Diff.	1900	Diff.	1910
12......	33	−5	28	−4	24	38	−9	29	−7	22
22......	86	−16	70	−14	56	75	−8	67	−17	50
32......	107	−20	87	−10	77	99	−15	84	−17	67
42......	136	−21	115	0	115	120	−17	103	−13	90
52......	196	−30	166	+15	181	171	−10	161	−11	150
62......	328	+5	333	+31	364	285	+11	296	+ 8	304
72......	617	+88	705	+59	764	564	+93	657	+30	687
82......	1389	+197	1586	−63	1523	1261	+111	1372	+46	1418

EXPECTATION OF LIFE—GENERAL POPULATION.

	Males					Females				
12......	46.3	+2.2	48.5	+0.6	49.1	47.9	+1.6	49.5	+1.8	51.3
22......	38.6	+1.9	40.5	+0.3	40.8	40.3	+1.2	41.5	+1.4	42.9
32......	32.1	+1.2	33.3	−0.2	33.1	33.6	+0.9	34.5	+0.6	35.1
42......	25.6	+0.6	26.2	−0.4	25.8	26.9	+0.4	27.3	+0.2	27.5
52......	19.3	0	19.3	−0.3	19.0	20.2	0	20.2	−0.1	20.1
62......	13.6	−0.6	13.0	−0.1	12.9	14.5	−0.7	13.8	−0.2	13.6
72......	8.5	−0.5	8.0	+0.3	8.3	9.2	−0.7	8.5	−0.1	8.4
82......	4.5	−0.1	4.4	+0.2	4.6	5.4	−0.6	4.8	+0.2	5.0

In conclusion, similar results computed by the same methods but on a quinquennial basis and therefore for different ages but based upon the *general population* (*i. e.*, including all the groups considered separately above) are quoted from a paper by the writer which appeared in *Science*, July 7, 1916. In that paper the statistical data comprised those used in this article plus those of the District of Columbia, except that Delaware was

included in 1890 but excluded in 1900 and 1910, and Indiana, Maine and Michigan were included in 1900 and 1910. In comparing these results with those given above, the differences in the ages should also be noticed and taken into consideration.

The essential conclusions drawn in that paper (which are evident on examination of the tables) are that there was an average gain of a year and a half per decade in the average duration of life but *in spite* of considerable retrogression at higher ages. The results of that paper, though based on a slightly different population, serve, then, to summarize the results of this paper, giving approximately proper weight to the relative size of populations involved.